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Krulikowski, III et al.

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[54] METHOD AND DEVICE FOR THE INSTALLATION OF DOUBLE HULL PROTECTION

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[21] Appl. No.: **656,791**

[22] Filed: **Feb. 19, 1991**

[51] **Int. Cl.**[5] .......... **B03B 25/12**

[52] **U.S. Cl.** .......... **114/74 A**; 114/83; 114/84; 188/374; 293/133

[58] **Field of Search** .......... 114/11, 12, 13, 74 A, 114/79 R, 79 W, 80, 81, 83, 84, 87, 88; 293/133; 188/377, 374, 371; 296/189

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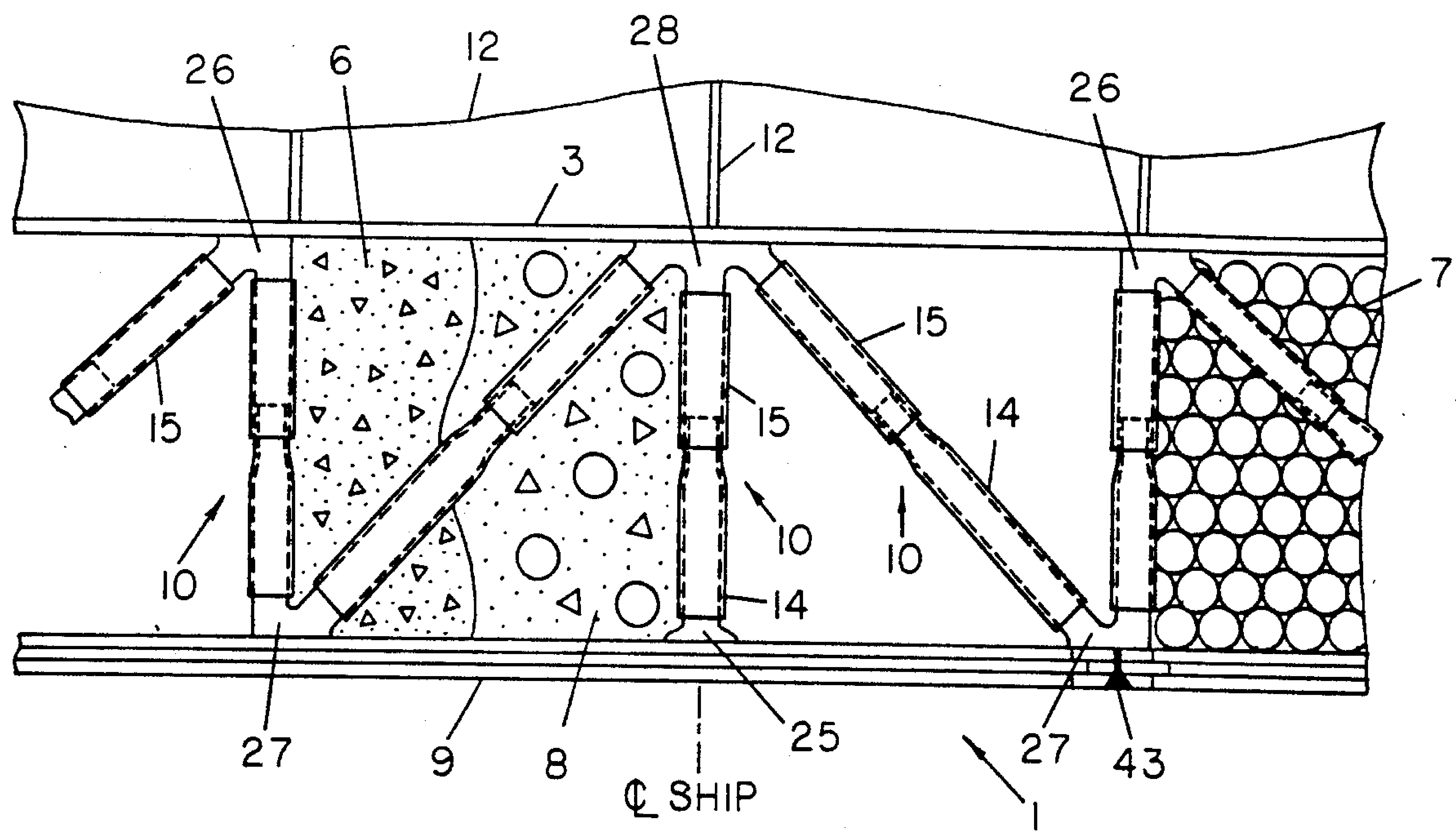
[57] **ABSTRACT**

A method and device for constructing a auxiliary hull, exterior to the primary hull of a ship, which has the capacity to absorb impact energy preventing primary hull puncture, and can be easily retrofitted to existing ship hulls. This method and device involves the use of energy absorbing members arranged in a truss-like formation to support the auxiliary hull shell. The auxiliary hull shell can be laminated to weaken interlaminar shear strength and further increase energy absorption during impact and thus prevent auxiliary hull puncture. This method and device also allows for the void spaces created between the primary and auxiliary hull shells to be filled with material which will, distribute the impact forces to the primary hull over a wider primary hull area, serve to support the auxiliary hull shell under hydrostatic forces and provide additional buoyancy forces if the auxiliary hull shell is punctured.

**9 Claims, 13 Drawing Sheets**



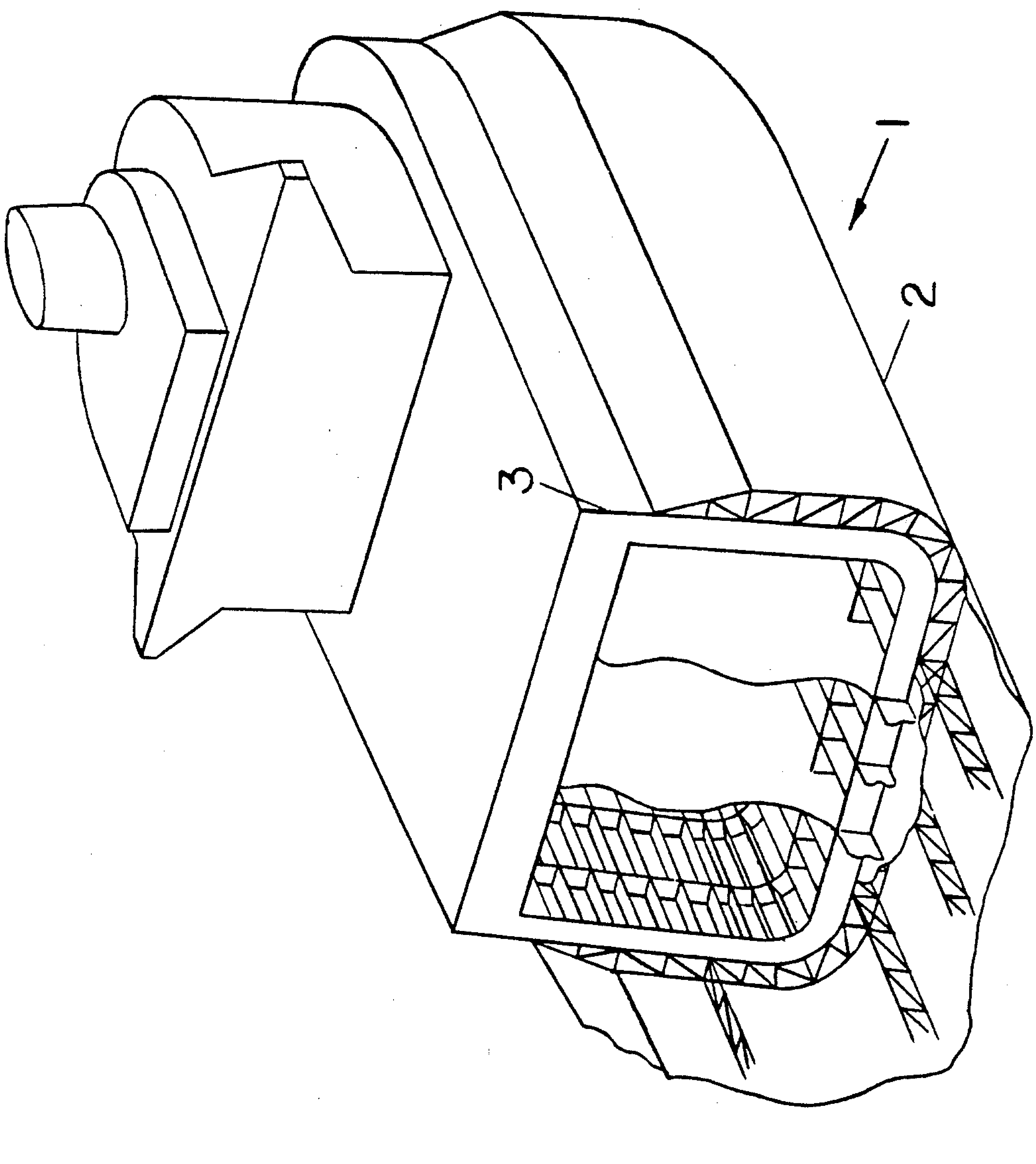



FIG 1

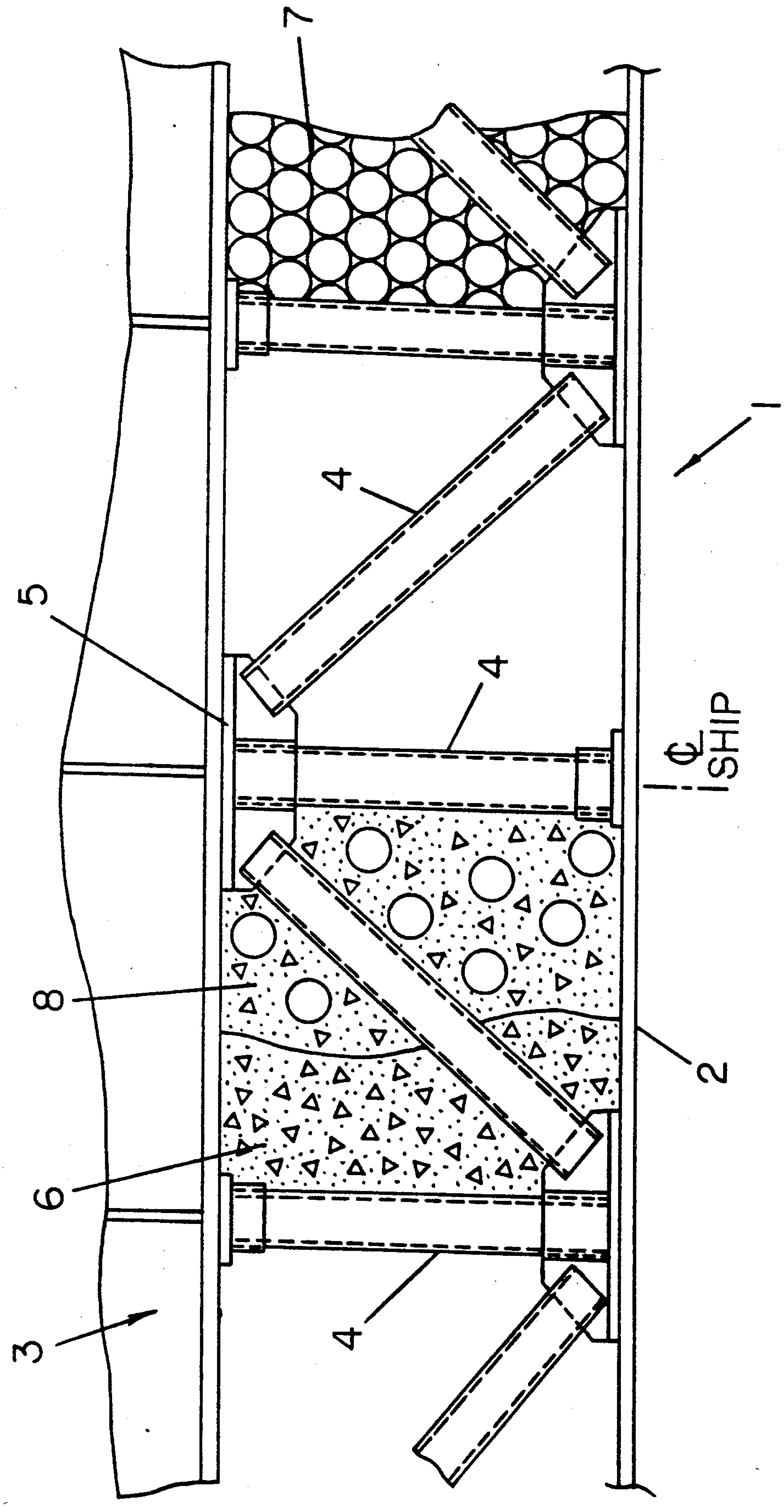



FIG 2

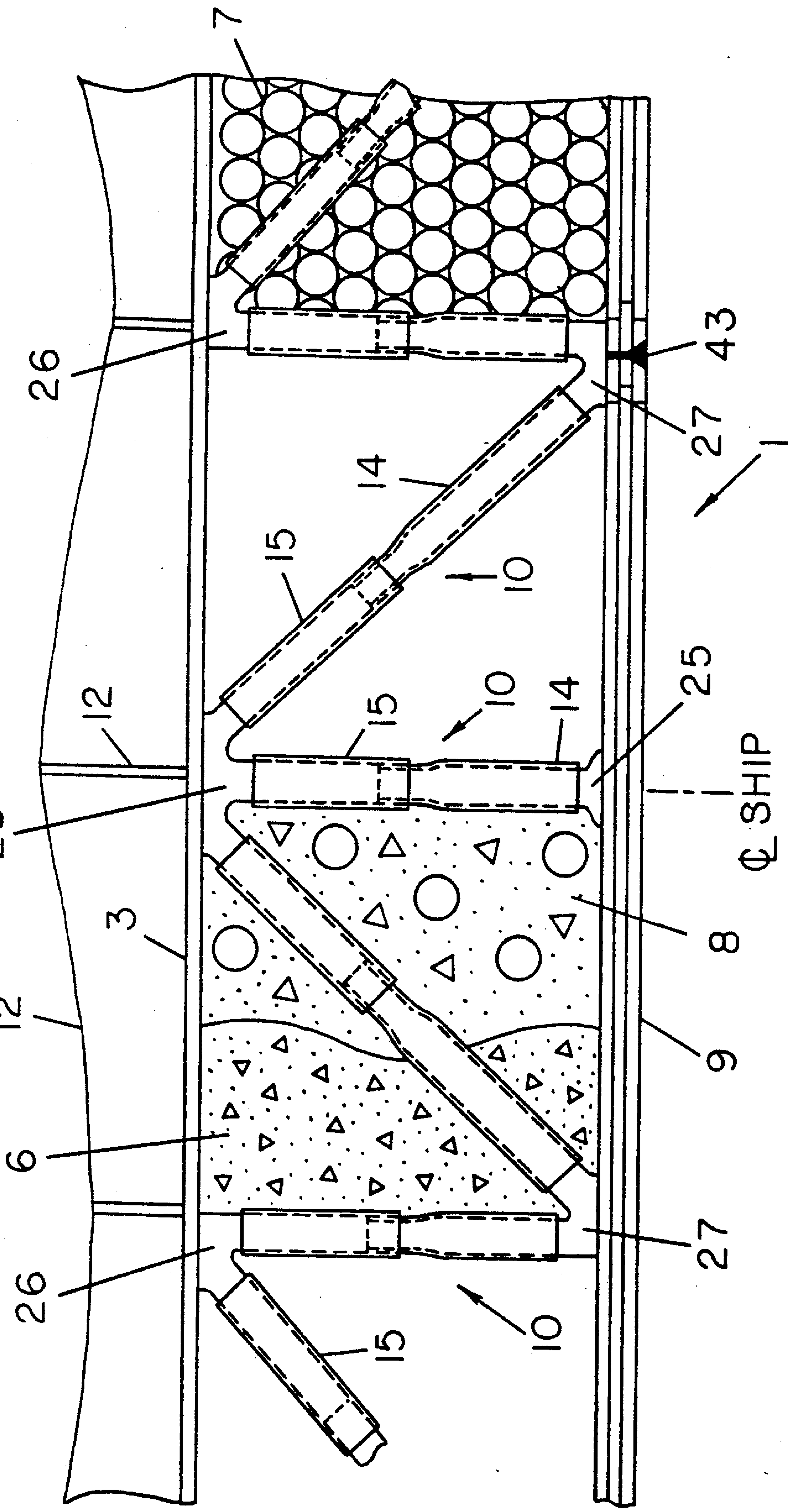



FIG 3

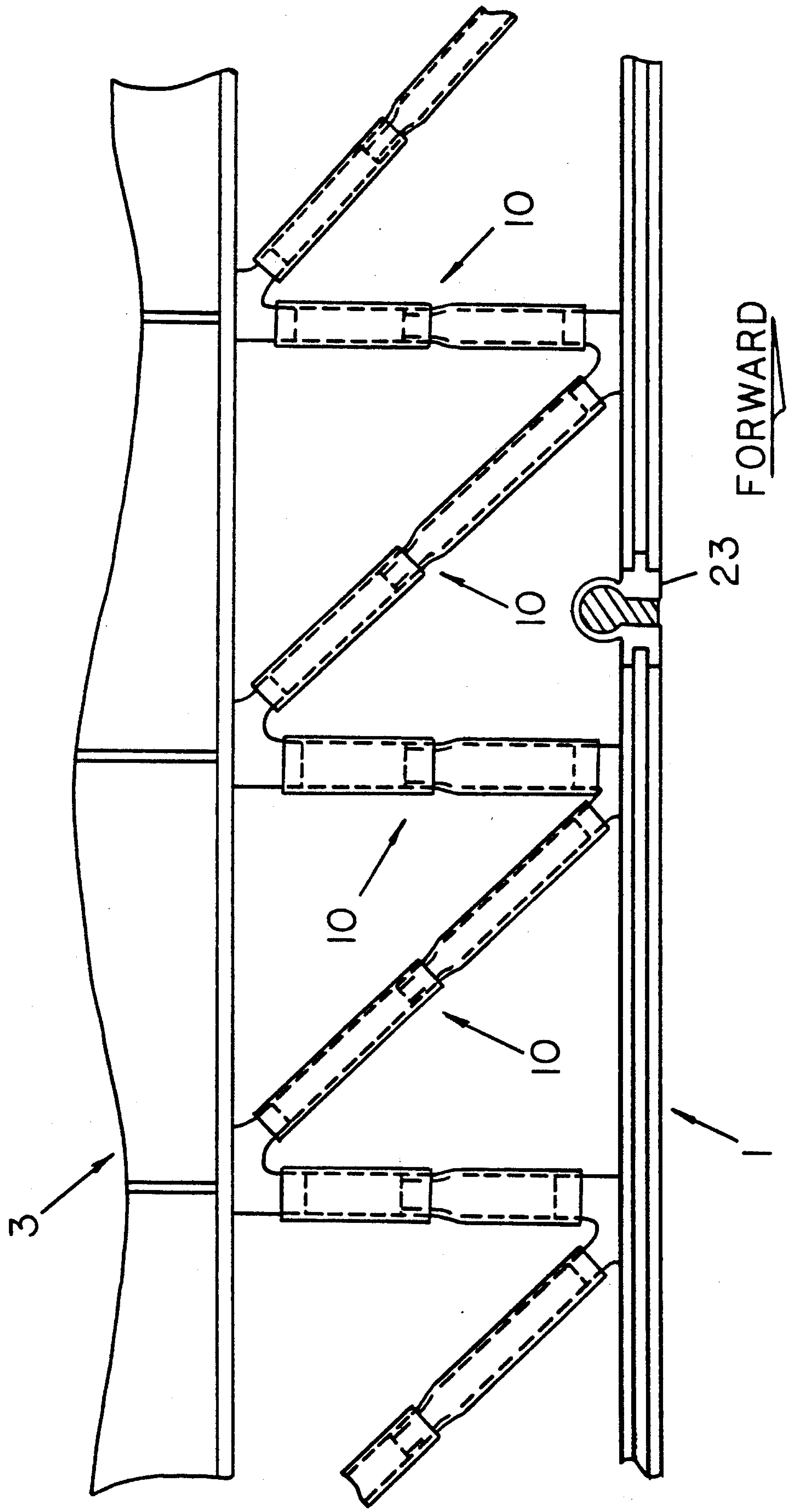



FIG 4

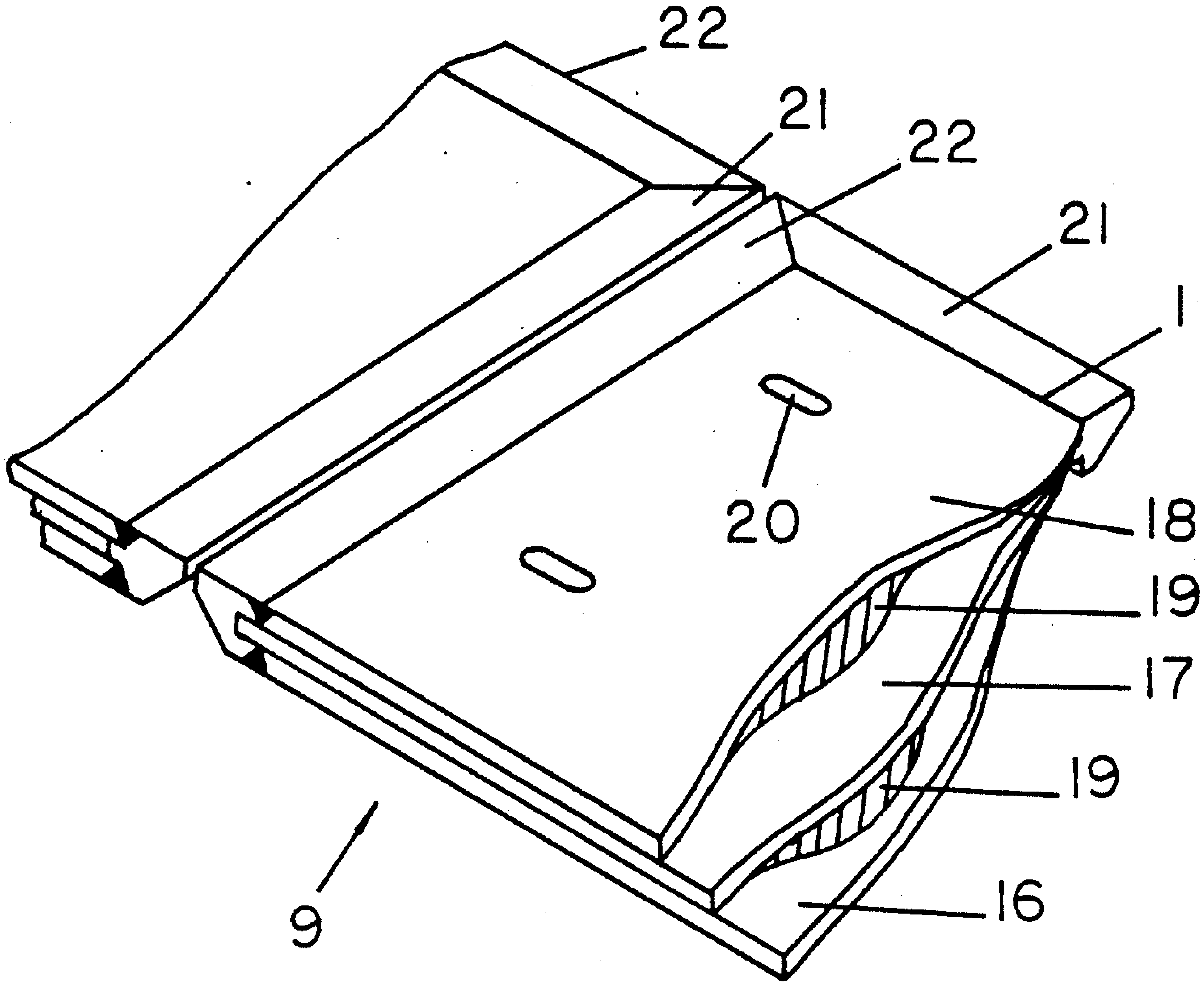



FIG 5

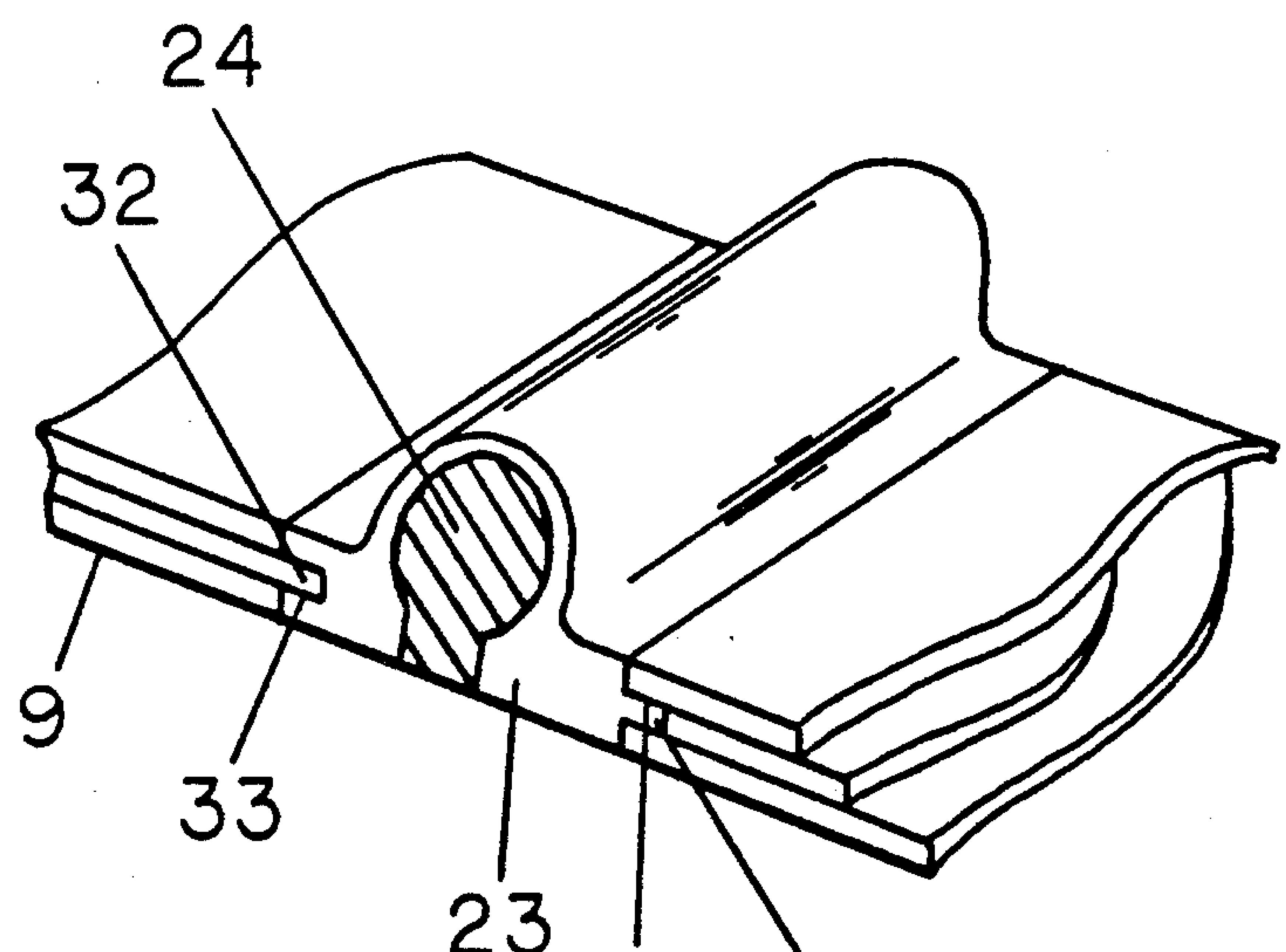



FIG 6

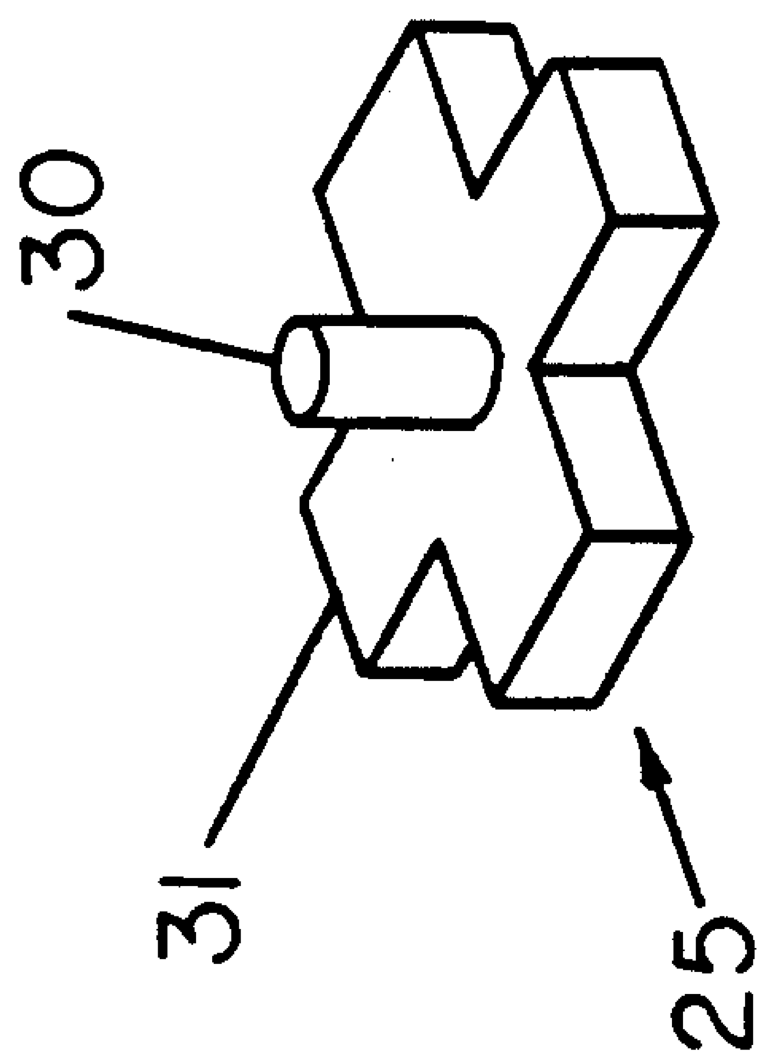


FIG 7

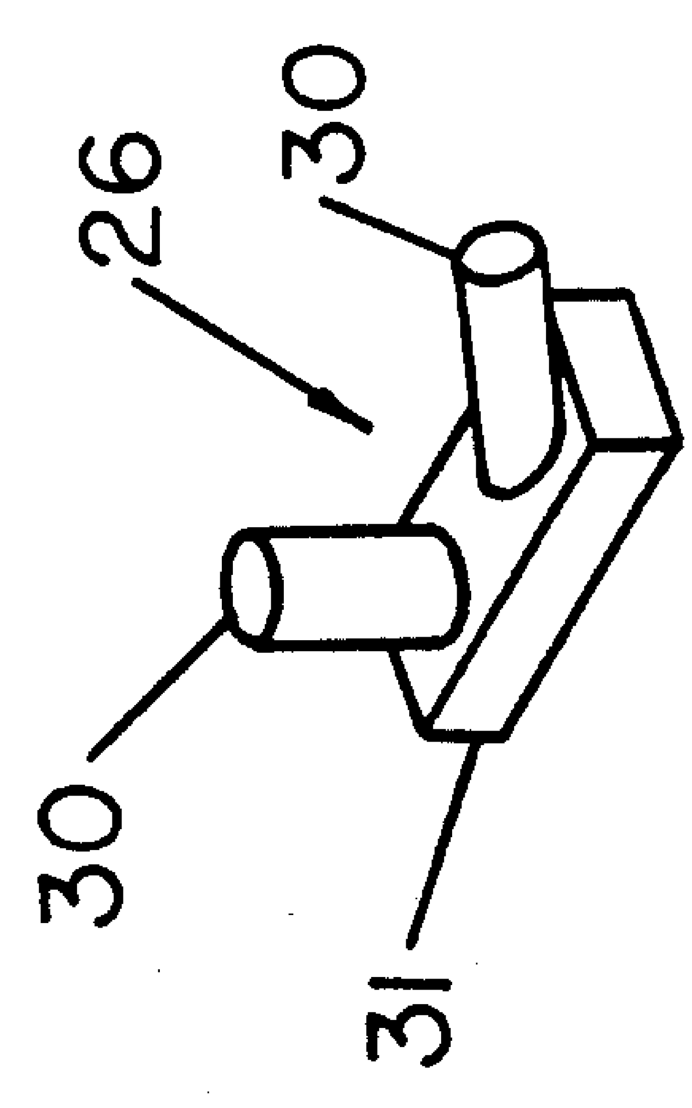


FIG 8

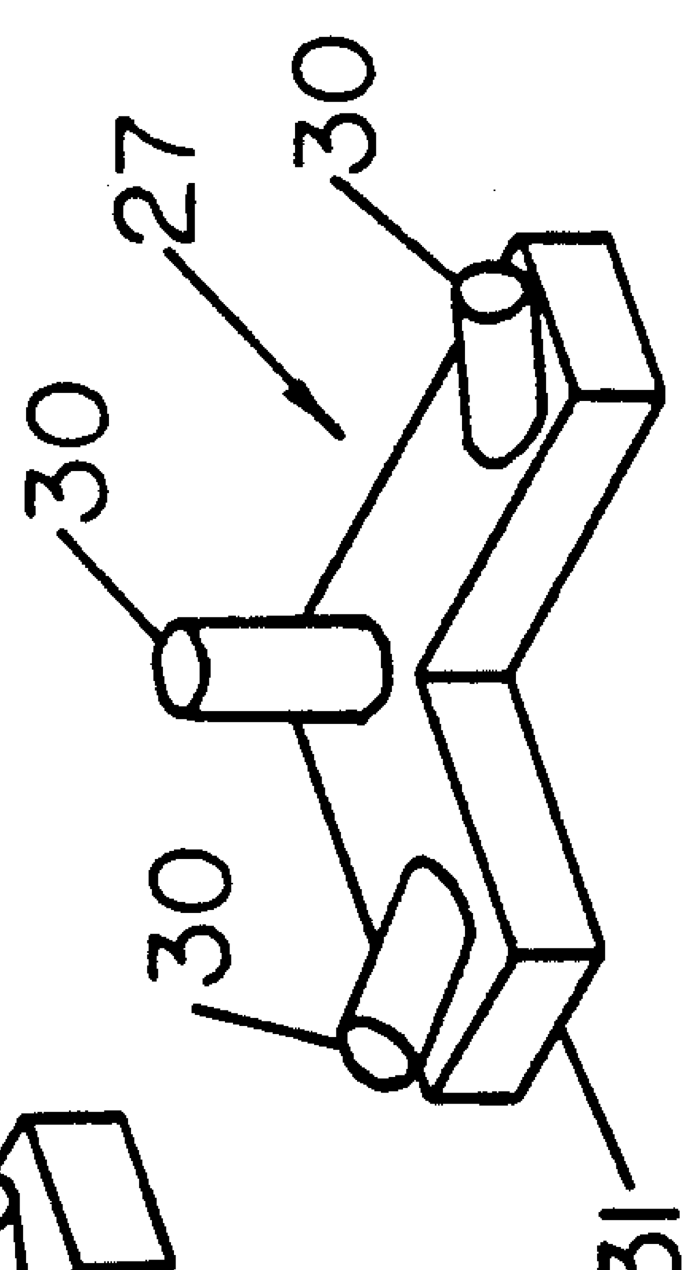


FIG 9

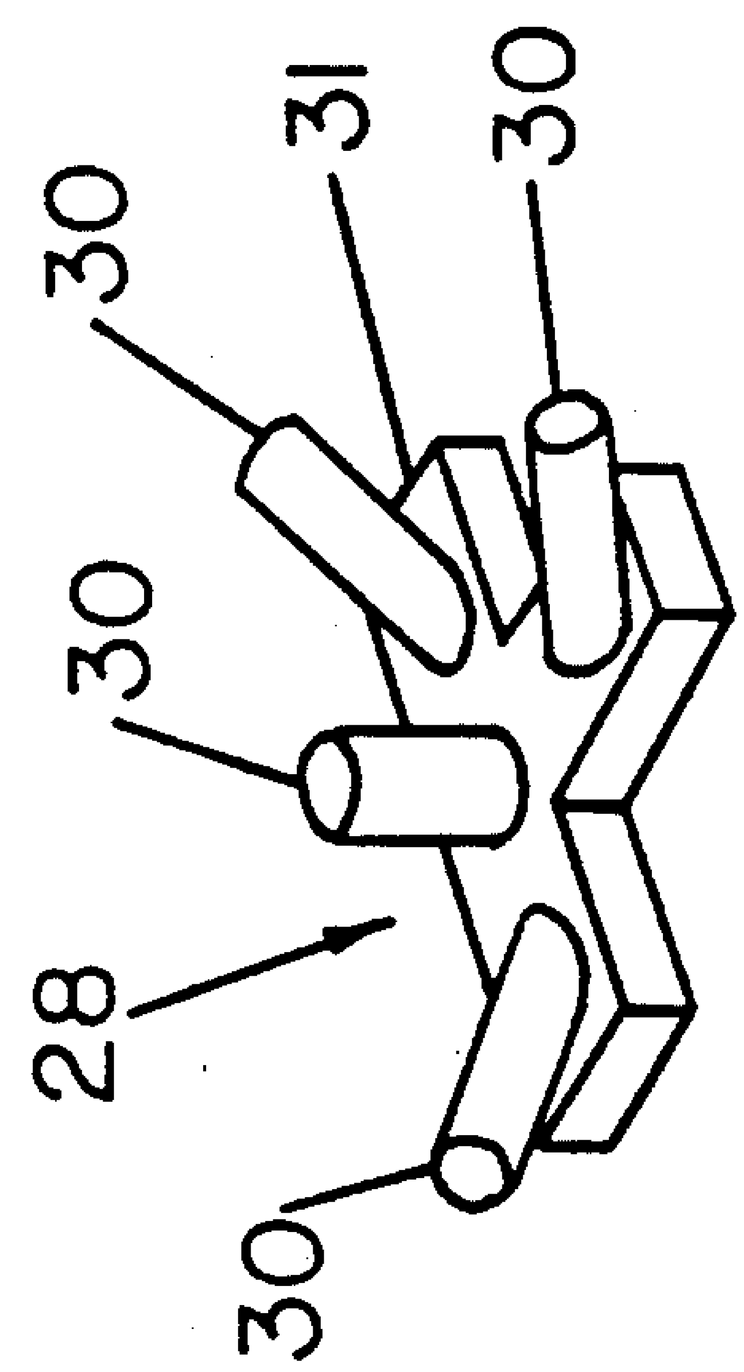


FIG 10

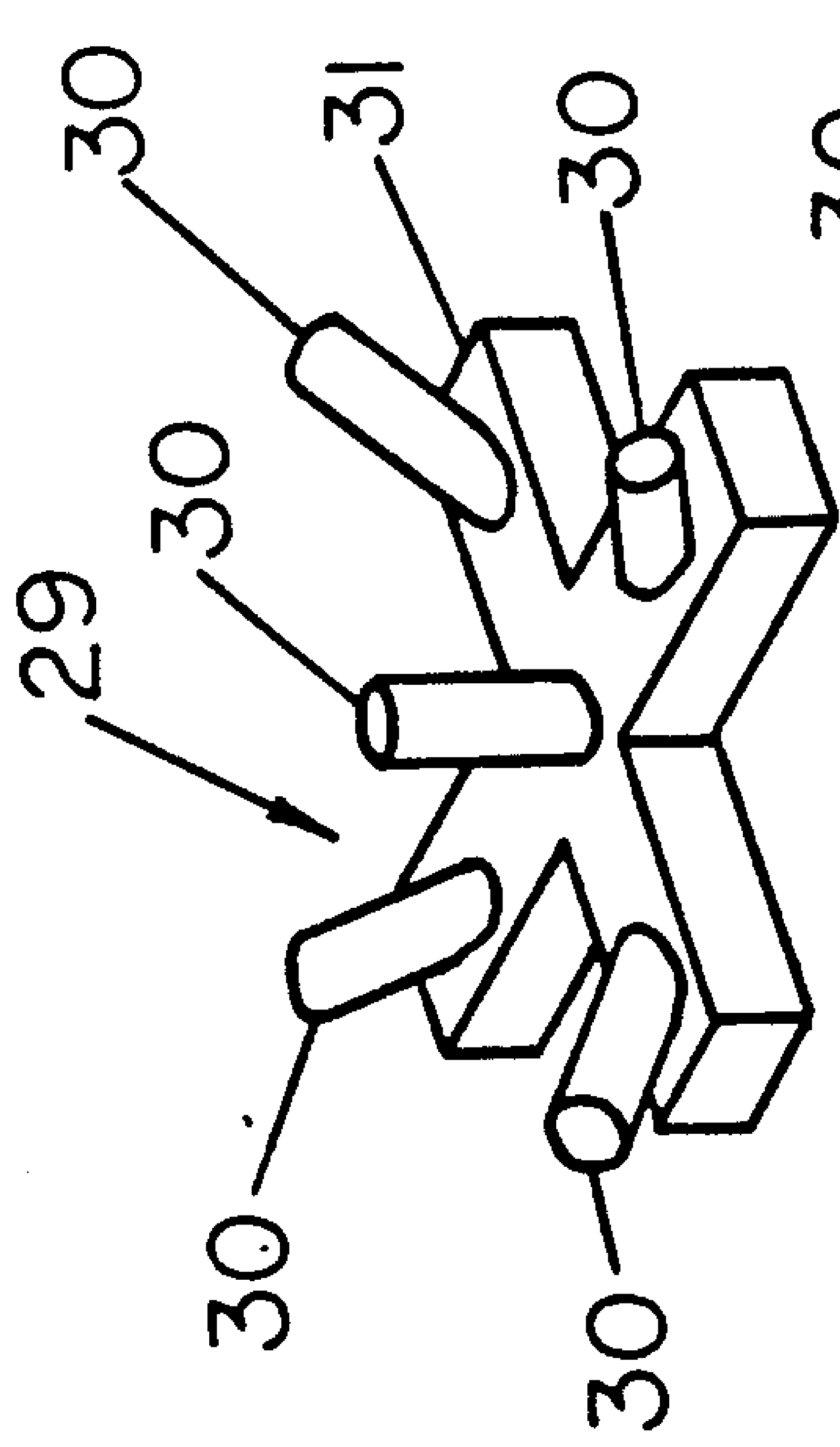


FIG 11

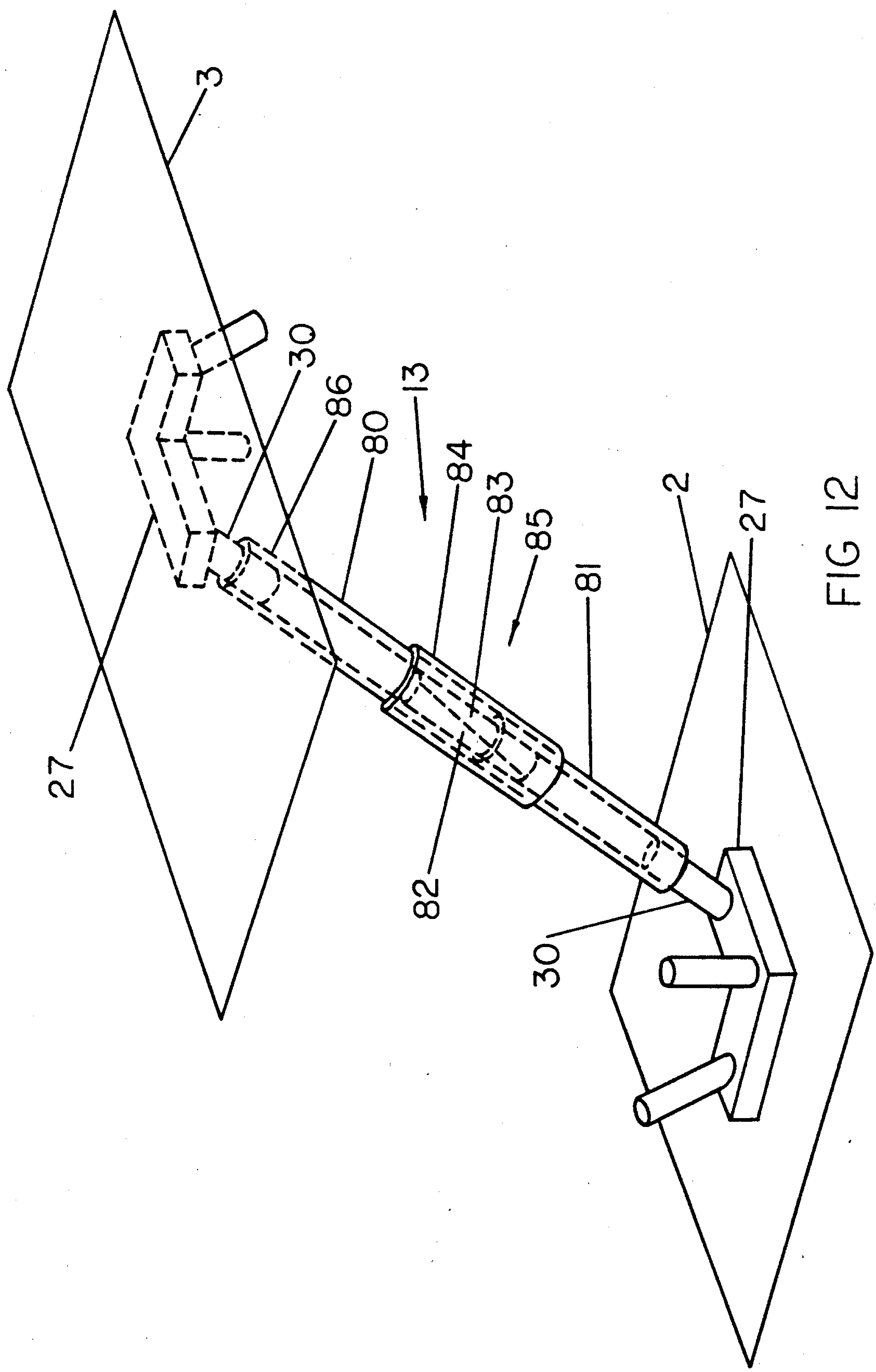



FIG 12

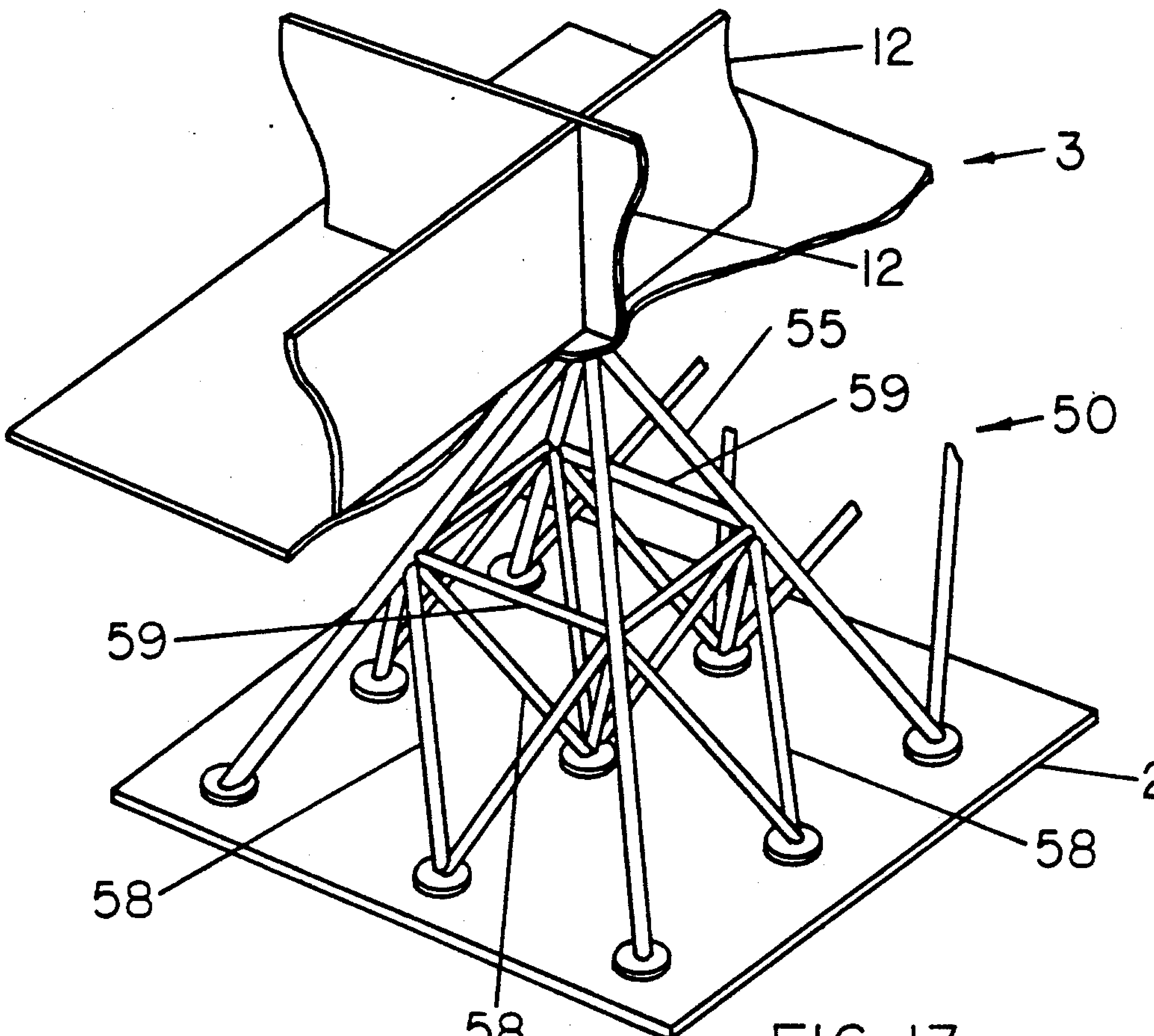



FIG 13

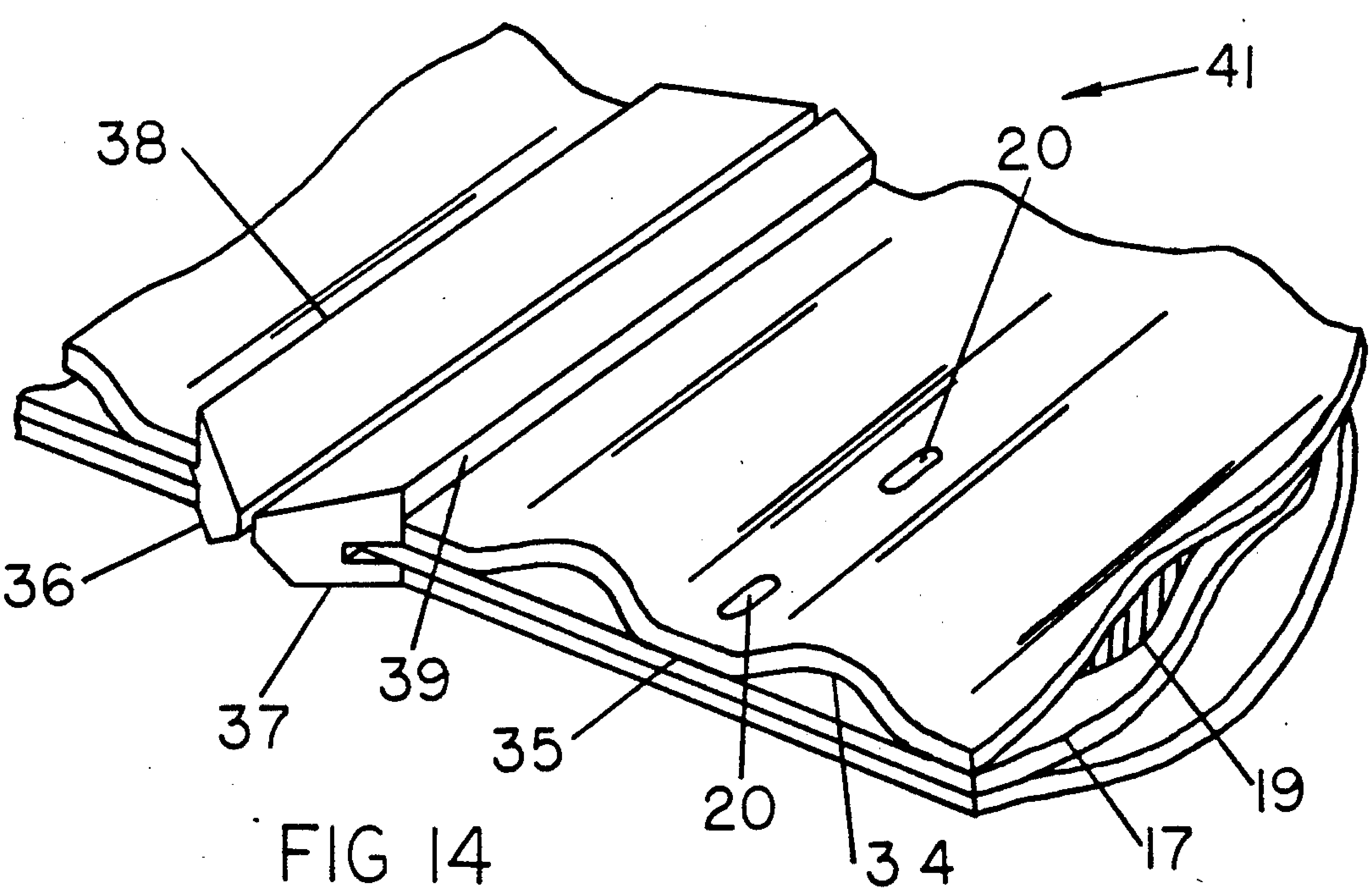



FIG 14

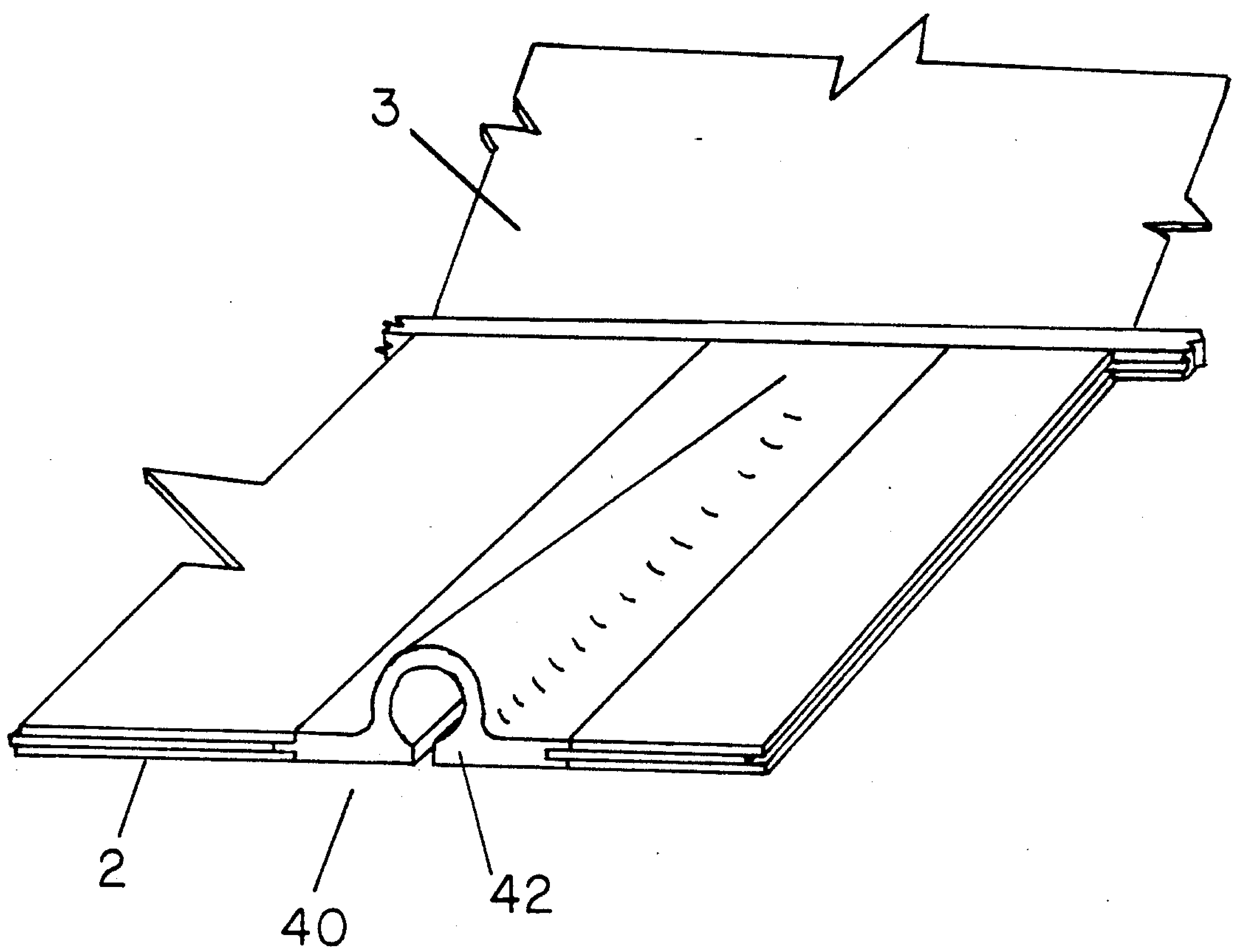



FIG 15

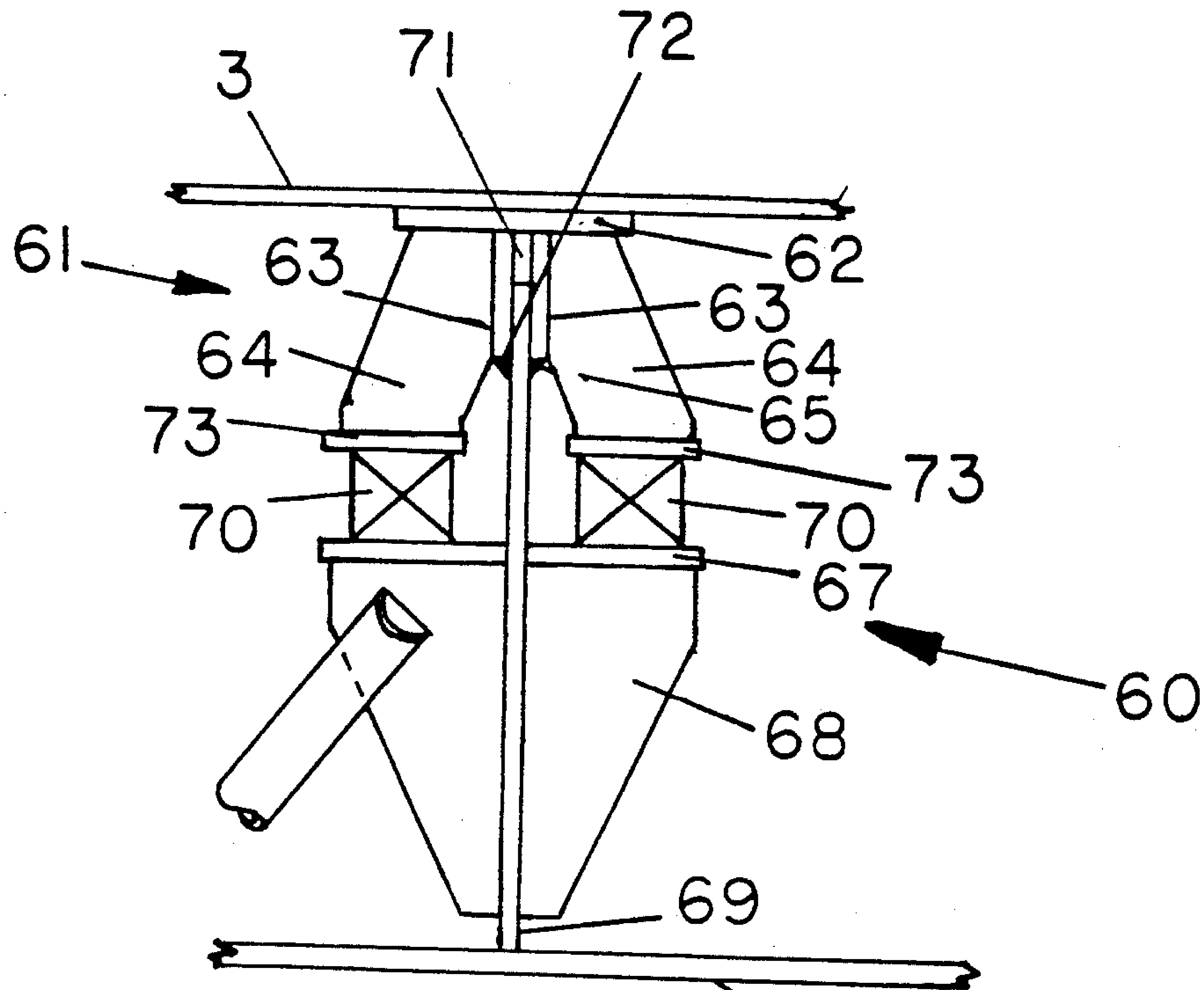



FIG 17

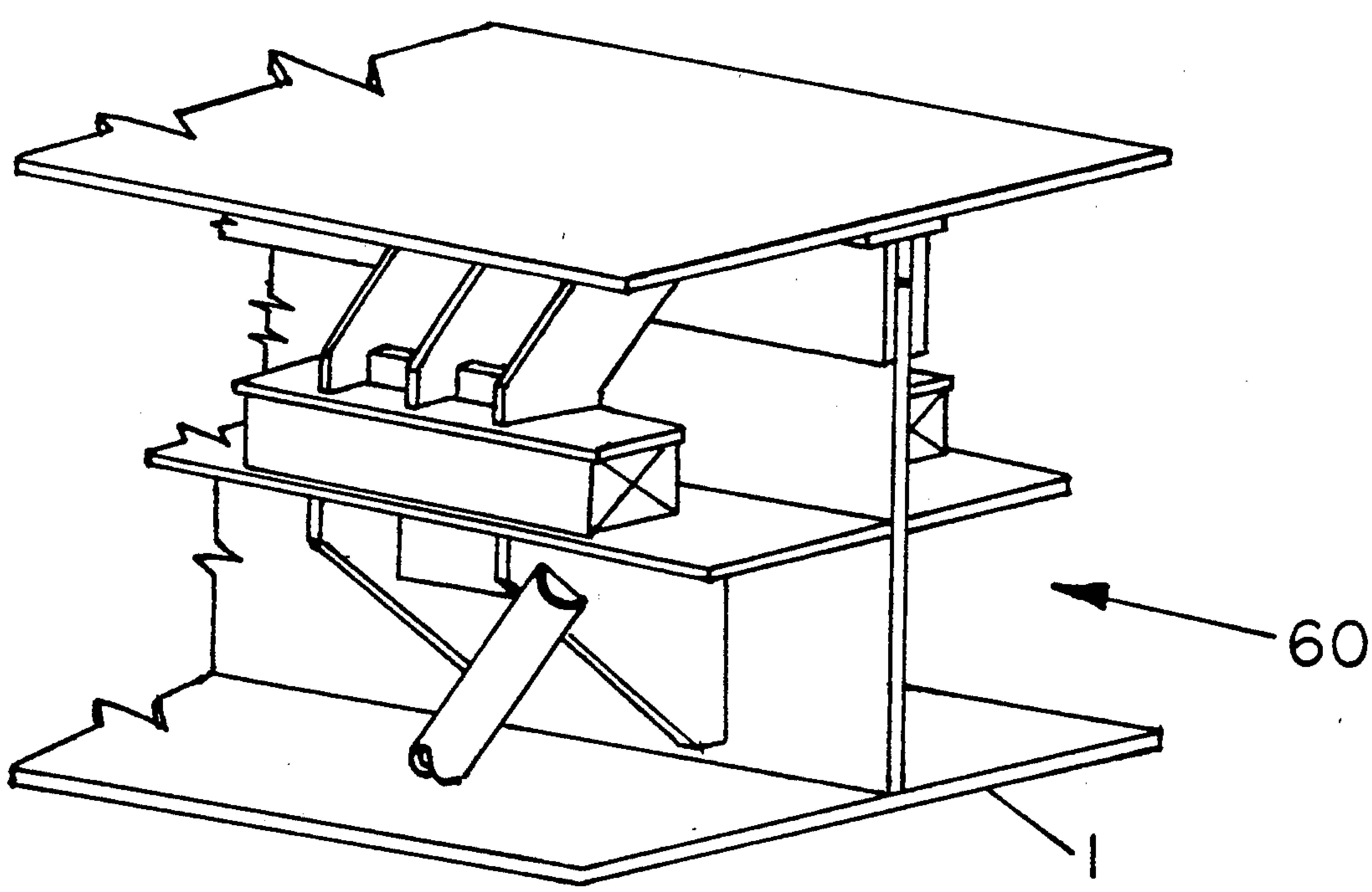



FIG 16

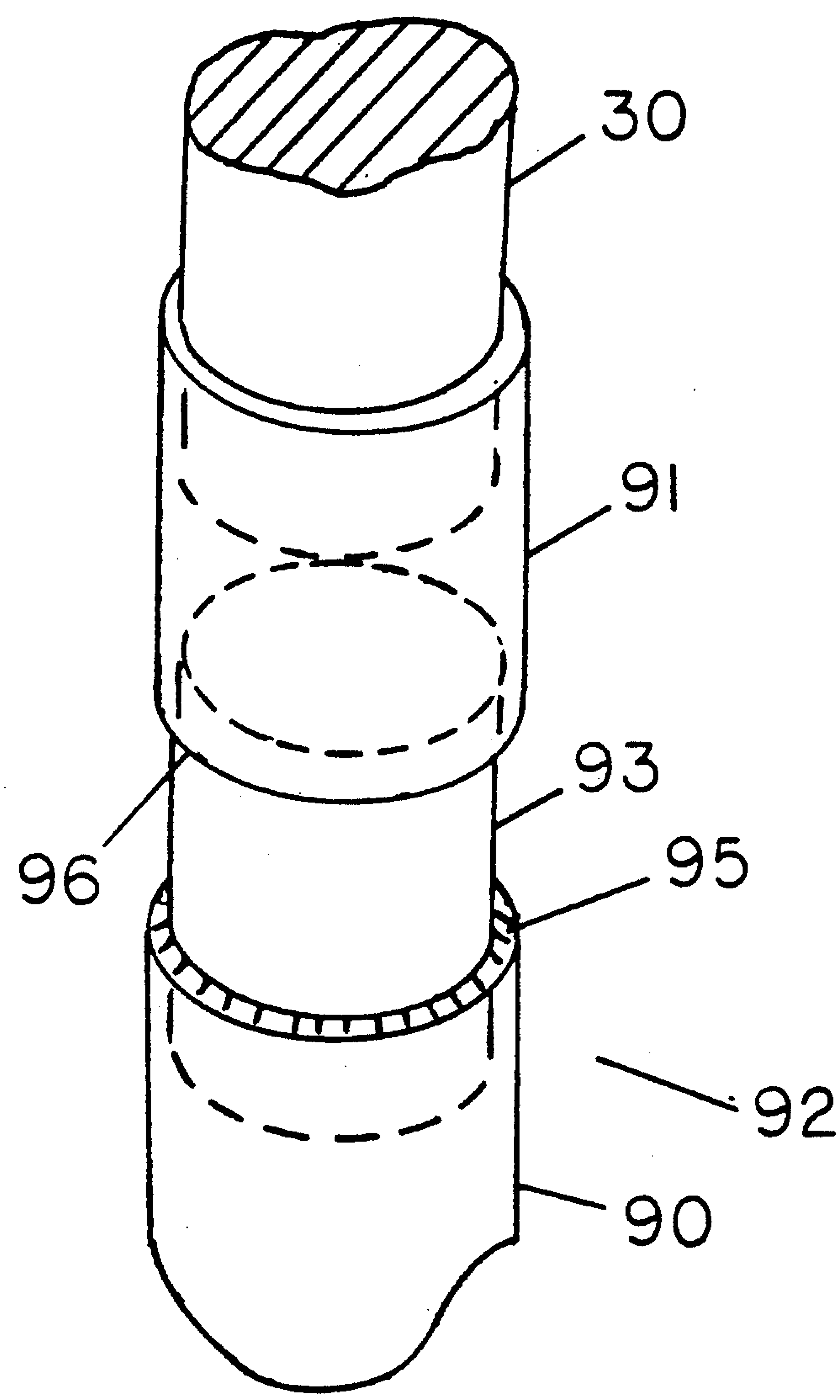



FIG 18

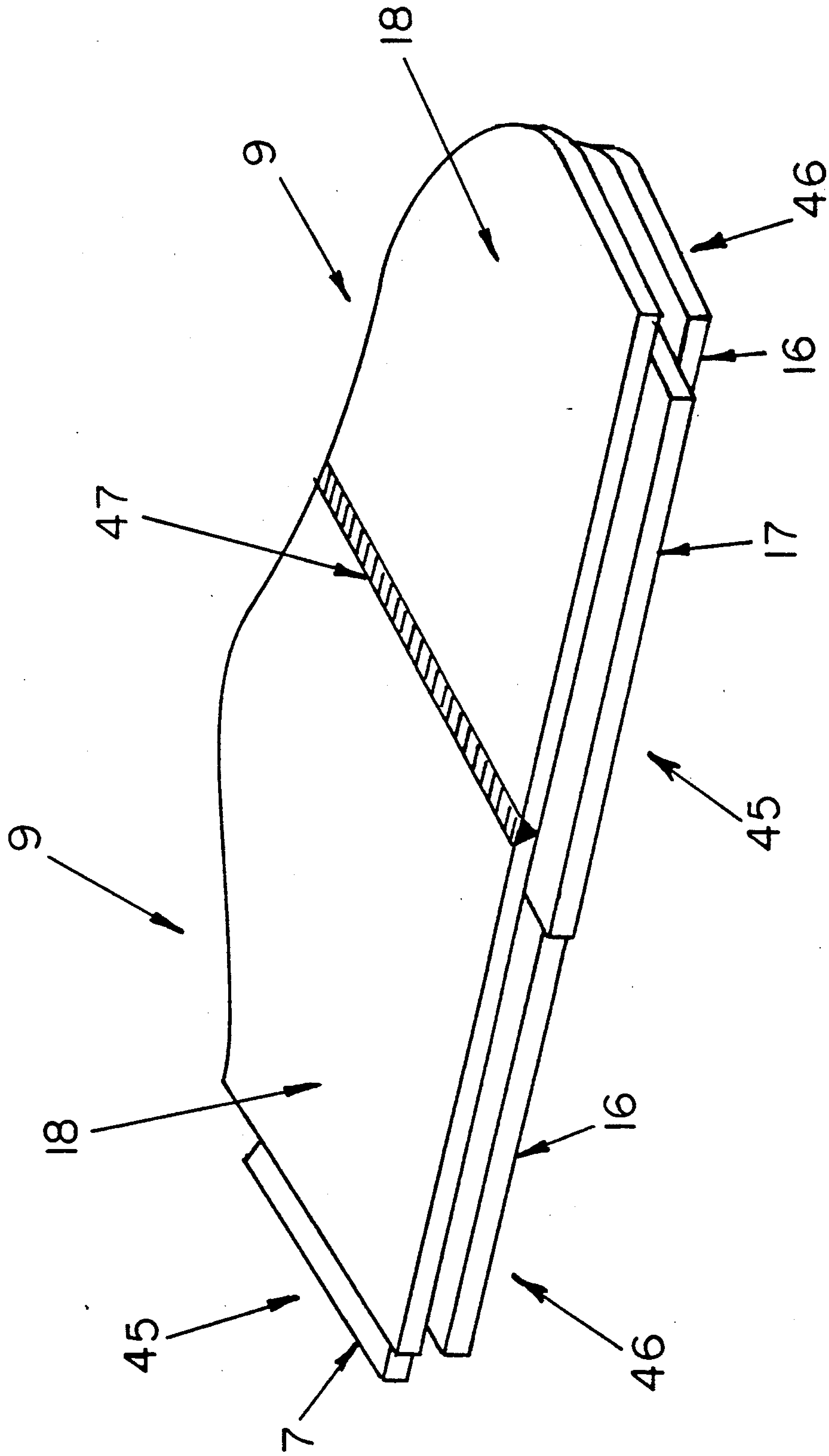



FIG 19

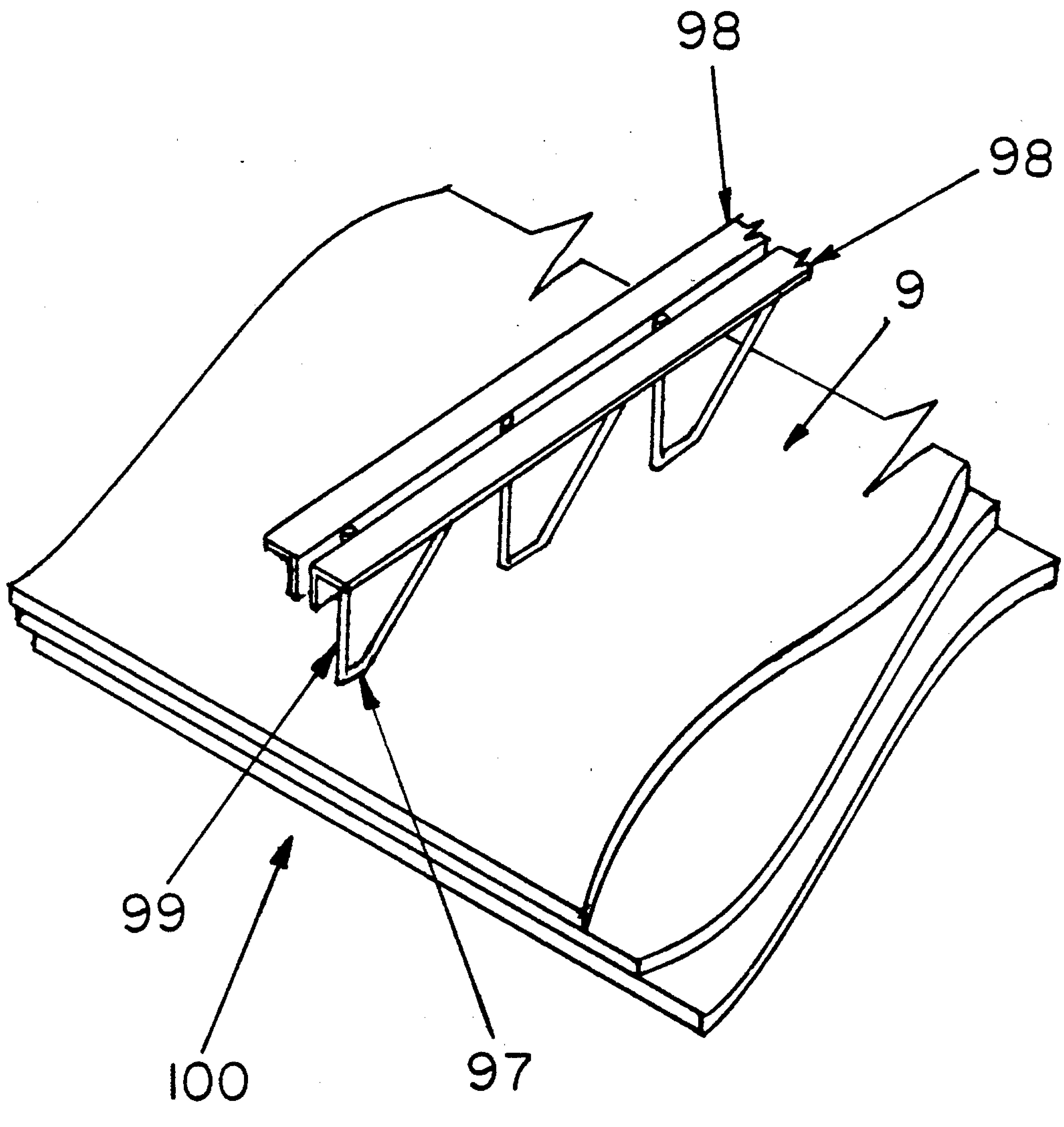



FIG 20

# METHOD AND DEVICE FOR THE INSTALLATION OF DOUBLE HULL PROTECTION

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and device for constructing a auxiliary hull exterior to the existing primary hull of a ship. This invention will prevent punctures of the primary hull from impact and collision.

2. Description of the Prior Art

In the past, most double hulled construction was comprised of inner bottoms and side shell bulkheads. While this method was expensive, it was feasible for new construction. For retrofit construction this method is prohibitively expensive and impractical. During retrofit the installation of inner bottom and bulkhead plating is extremely difficult due to access and interference problems. Also this results in the loss of ship's capacity in addition to expensive piping modifications.

## SUMMARY OF THE INVENTION

The object of this invention is to provide a method and device regarding the installation of double bottoms and double hulls on existing ships. This method and device for constructing a auxiliary hull, exterior to the primary hull, has the capacity to absorb impact energy preventing primary hull puncture, and can be easily retrofited to existing ship hulls. This method involves the use of members and or energy absorbing compression and tension members arranged in a truss-like formation to support the auxiliary hull shell. The auxiliary hull shell can be laminated to weaken interlaminar shear strength and further increase energy absorption during impact and thus prevent auxiliary hull puncture. This method also allows for the void spaces created between the primary and auxiliary hull shells to be filled with material which will, distribute the impact forces to the primary hull over a wider primary hull area, serve to support the auxiliary hull shell under hydrostatic forces, provide lateral support to the truss members and plating, and will minimize the loss of buoyancy forces due to auxiliary hull rupture from impact. Cost saving advantages of this invention are; ease of installation due to truss-like construction which permits the use of easily managed tools, reduced time of installation due to simplified production and labor requirements, and lower cost of materials. Technical advantages of this invention are; reduce hull punctures and loss of buoyancy by the use of energy absorbing and load distributing designs and materials, increased payload by allowing potable water and other nonpollutant tanks between primary and auxiliary hulls, allow for pipe runs outside the primary hull, and maintain or potentially increase payload by adding less weight then additional added buoyancy. An additional, and significant, technical advantage includes the ability to control primary hull stresses in the auxiliary hull by using stress/deflection control devices. A more complete understanding of the invention may be had by review of the figures and description of the preferred embodiment.

## BRIEF DESCRIPTION OF THE DRAWINGS

Certain embodiments of the invention are shown, reference being made to the accompanying drawings, in which:

FIG. 1 is a isometric view of the after portion of a tanker ship with a transverse cut line, illustrating the invention.

FIG. 2 is an elevation view of the truss structure oriented in the ships transverse direction, illustrating the truss members and the use of different void fill materials.

FIG. 3 is an elevation view of the truss structure oriented in the ships transverse direction, illustrating the use of energy absorbing compression truss member assemblies and cast joint devices.

FIG. 4 is an elevation view of the truss structure oriented in the ships longitudinal direction, illustrating the truss member assemblies configured to provide compressive resistance under probable impact forces.

FIG. 5 is an isometric view of the auxiliary hull shell, illustrating the use of laminated plating and associated butt joint design.

FIG. 6 is an isometric view of a laminated plate assembly and a stress/deflection controlling device which has the capability to relieve loads and allow deflection in the laminated plate assembly.

FIG. 7 is an isometric view of a cast joint device with a single appendage, used to attach a member or member assembly to the auxiliary hull shell or to the primary hull.

FIG. 8 is an isometric view of a cast joint device with two appendages, used to attach members or member assemblies to the auxiliary hull shell or to the primary hull.

FIG. 9 is an isometric view of a cast joint device with three appendages, used to attach members or member assemblies to the auxiliary hull shell or to the primary hull.

FIG. 10 is an isometric view of a cast joint device with four appendages, used to attach members or member assemblies to the auxiliary hull shell or to the primary hull.

FIG. 11 is an isometric view of a cast joint device with five appendages, used to attach members or member assemblies to the auxiliary hull shell or to the primary hull.

FIG. 12 is an isometric view of a truss member assembly, illustrating the use of energy absorbing tension truss member assemblies.

FIG. 13 is an isometric view of a space truss assembly, illustrating the support of the auxiliary hull shell.

FIG. 14 is an isometric view of the auxiliary hull shell illustrating the use of laminated plating with the interior plate shaped for additional strength.

FIG. 15 is an isometric view of a transition piece for the stress/deflection controlling device.

FIG. 16 is a isometric view of the construction support assembly.

FIG. 17 is an elevation view of the details for the construction support assembly.

FIG. 18 is an isometric view of a portion of a compression truss member assembly capable of supporting load after initial failure.

FIG. 19 is an isometric view of a portion of two laminated shell assemblies illustrating a method of joining, using tongue and groove interfaces.

FIG. 20 is an isometric view of a portion of a laminated plate assembly illustrating the use of bar support for laminated plate assembly stiffening.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The accompanying FIGS. **1** through **20** show the preferred embodiment of the invention which is a method and device for constructing a auxiliary hull exterior to the primary hull of a ship, which has the capacity to absorb impact energy and prevent primary hull puncture.

FIG. **1** is an isometric of the after portion of a tanker ship illustrating the auxiliary hull denoted by the number **1** comprised of an auxiliary hull shell **2** and steel truss members **4**, which is attached to the primary hull **3**.

FIG. **2** is a typical transverse cross section illustrating the assembly of the auxiliary hull **1**. The auxiliary hull shell **2**, is a steel plate which is held in place by steel truss members **4**, which are supported by the primary hull **3**, at locations having interior ships structure **12** so as to minimize primary hull deformations. The auxiliary hull shell **2**, is welded to the steel truss members **4**, which in turn are welded to the primary hull **3** using socket and gusset type connections **5**. Lateral support for the steel truss members **4** may be provided by filling the void between the auxiliary hull shell **2** and primary hull **3**, with a energy absorbing rigid polyurethane foam material **6**, or a energy absorbing polyurethane ball shaped material **7**, or a composition of polyurethane foam/ball material **8**. The preferred embodiment is the use of polyurethane foam/ball material **8**. This combination makes for a light weight, water tight and easily applied composite material effective in reducing steel truss member **4** size and weight, by laterally restraining the member, which increases buckling strength and the energy absorbed by the member before failure. It is also effective in supporting the auxiliary hull shell **2**, of the auxiliary hull **1**, under normal hydrostatic loads. The polyurethane foam/ball material **8** is effective in absorbing energy as it resists loads and fails during collisions. Localized loads on the auxiliary hull shell **2** are dispersed within the polyurethane foam/ball material **8** and reach the primary hull **3** over a much larger area eliminating failure of the primary hull **3**. The expected ultimate compressive strength of the polyurethane foam/ball material is 400 pounds per square inch. The use of this polyurethane foam/ball material **8** significantly reduces buoyancy loss due to auxiliary hull **1** puncture since the polyurethane foam/ball material **8** is water tight.

FIG. **3** is a typical transverse cross section of the second version of the preferred embodiment illustrating the assembly of the auxiliary hull **1**. The laminated plate assembly **9**, further illustrated in FIG. **5**, is a laminated plate assembly which is held in place by steel energy absorbing compression truss member assemblies **10**, which are supported by the primary hull **3**, at locations having interior ships structure **12** so as to minimize primary hull deformations. The diagonal compression truss member assemblies **10** have been arranged in opposite directions, as referenced from the ship's centerline, for maximum energy absorption during a side collision. The laminated plate assembly **9**, is welded to the energy absorbing compression truss member assemblies **10**, which in turn are welded to the primary hull **3**, using cast joint devices **25**, **26**, **27** or **28**, which are further illustrated in FIGS. **7**, **8**, **9**, and **10**. Lateral support for the compression truss member assemblies **10**, can be provided by filling the void between the laminated plate assembly **9** and primary hull **3**, with the described foam material **6**, or ball shaped material **7**, or a composition of foam/ball material **8**. The energy absorbing compression truss member assemblies **10** are comprised of two steel tube elements **14** and **15**, which are connected via a male female joint. The sequence of the energy absorbing mechanism is as follows. Initially when impact is made a compressive force is generated in the compression truss member assembly **10**. The weld attaching the two steel tube elements **14** and **15** of this member assembly **10** will absorb load until its shear capacity is reached. Failure of the weld will occur allowing the member assembly **10** to shorten as the two elements **14** and **15** are pressed together. Three positive effects for energy absorption are occurring during this phase of the mechanism. First, as the tapered portion of element **14** enters element **15**, elastic/plastic circumferential strains begin in both elements absorbing energy as they progress. Second, the two elements wanting to retain their unstrained cross sectional shape impart a large normal pressure upon themselves relative to the outside surface of element **14** and the inside surface of element **15**. This pressure multiplied by the interface area, again multiplied by the coefficient of dynamic friction gives the column compressive force required to maintain a constant rate of member shortening at any time. Noting that the interface area continues to increase as the member shortens, the force required to maintain a constant rate of shortening must also increase. This mechanism is very effective in absorbing a large amount of energy. Third, the compressive loads acting on the member assembly **10** are oriented axially relative to the member assembly. The member assembly **10** may then be considered a column under compression and therefore column buckling is of concern. The nature of the energy absorbing mechanism effectively counters column buckling tendencies in two ways; one, the member assembly shortens as the mechanism progresses, and two, the center cross section of the member assembly increases as the two elements mate. Both conditions dramatically increases the stiffness of the member reducing the possibility of buckling.

FIG. **4** is a typical longitudinal cross section of the second preferred embodiment illustrating the auxiliary hull **1** with the truss diagonal compression truss member assemblies **10** arranged in a downward and forward direction from the primary hull **3** for maximum energy absorption during a forward collision. A stress/deflection controlling device **23** is illustrated to show proper arrangement to relieve primary hull bending stresses.

FIG. **5** is an isometric of the laminated plate assembly **9**, that is comprised of an exterior plate **16**, center plate **17**, and interior plate **18** attached by the use of a structural adhesive **19** or a slot weld **20**, end tongue piece **21** and end groove piece **22**. End tongue piece **21** and end groove piece **22**, are used to permit shell welds **43** in joining the laminated plate assemblies **9**. This laminated plate assembly **9** acts as a solid plate under operational loads, however interlaminar shear forces under collision will be high enough to fail the plate bonds allowing the plate to belly and thus avoiding plate tearing. The polyurethane foam/ball material **8**, as shown in FIG. **3**, would then take more of the collision load and distribute it to the primary hull **3** over a large area eliminating localized failures of the primary hull **3**. Since by nature structural adhesives are waterproof, and allowable corrosion limits are specified in ship design, the plate thicknesses of the laminated plate assembly **9** can be adjusted such that the exterior plate **16** is equal to or less than the specified limit. This results in the structural adhesive **19** acting as a natural corrosion barrier when the exterior plate **16** has corroded through thus delaying further corrosion.

FIG. **6** is an isometric of a stress/deflection controlling device **23** which provides for deflection control thereby controlling the amount of stress in the laminated plate assembly **9** caused by deflection from bending of the primary hull **3** which is denoted in FIG. **4**. The cross section of this stress/deflection controlling devise **23** allows considerable deflection when plane loads in the laminated plate assembly **9** act perpendicular to its long axis. This devise **23**, as shown, is an omega shape, however it can be any offset geometric shape, welded between sections of laminated plate assembly **9**. The welded connection is formed with a tongue **32** and groove **33**. The interior of this devise **23** is filled with a flexible material **24**, such as rubber or silicone caulk. This will make for a smooth shell and therefore less resistance as the hull travels through the water.

FIG. **7** is an isometric of a cast joint device **25** comprised of an appendage **30** and base **31** for a single truss member assembly. The appendage **30** matches the inside geometry of the steel tube elements and allows for easy adjustment of truss member assembly length by providing a range of locations suitable for welding along the length of the appendage **30**. This appendage **30** can be cast economically in a large number of predetermined angular positions to receive steel tube elements such that a variety of standard cast joint devices can be used in different locations to facilitate fabrication. The base **31** of the cast joint device **25** can be cast in various root geometries to facilitate welding preparation. The device **25** can be welded to the outer side of the primary hull **3** or to the inner side of the auxiliary hull **1** as shown in FIG. **3**. In this preferred embodiment five types of cast joint devises are utilized.

FIGS. **8**, **9**, **10** and **11** illustrate the different types of cast joint devises **26** through **29** with varying number of connection appendages **30** and base **31** geometries. These cast joint devises welded to the outer side of the primary hull **3**, as shown in FIGS. **3** and **4**, at locations having interior ships structure **12** so as to minimize primary hull deformations. The width **11** of the bases **31** of devices **25** through **29** will be based on the thickness of the shell plating to avoid secondary stresses caused by truss member assembly loading. The loads in the truss member assemblies will be transferred to the primary hull structure by way of these cast joint devises.

FIG. **12** is an isometric of a energy absorbing tension truss member assembly **13**. This tension truss member assembly **13** shown in a cylindrical shape with a circular cross-section could have substantially any shaped cross-section. As depicted, the steel tube element **80** and steel tube element **81** are connected using two wedges **82** and **83** and a sleeve **84**. The two wedges **82** and **83** are formed such that when the inclined faces are mated the resultant outside diameter will substantially match the inside diameter of the two steel tube elements **80** and **81** respectively. The inside diameter of the sleeve **84** substantially matches the outside diameter of the two steel tube elements **80** and **81**. Either steel tube element **80** or **81** can be inserted into sleeve **84**. Sleeve **84** can be pushed along the steel tube element out of the way of the tube element interface **85**. The wedges **82** and **83** can be mated and inserted into the interface end of steel tube element **80**. The thin end of the wedge **83** can be welded to the steel tube element **80**. Steel tube element **81** can then be slid onto the two wedges **82** and **83**. Connection to the cast joint device **27**, and truss member assembly **13** length, can be made by sliding steel tube element **81** onto the wedges **82** and **83** as far as possible, inserting the female end **86** of steel tube element **80** onto the appendage **30** of the cast joint device **27** which is attached to the primary hull **3**, rotating the tension truss member assembly **13** so that it is in line with the appendage **30** of the cast joint device **27** which is attached to the auxiliary hull shell **2**, then sliding steel tube element **81** onto the appendage **30** of cast joint device **27**, adjusting for proper fit and welding steel tube element **81** to wedge **82**. Next, welding steel tube element **80** and **81** to their respective cast joint devices **27**, sliding the sleeve **84** over the wedges **82** and **83** and welding to steel tube elements legs **80** and **81**. The following is the mechanism allowing for energy absorption under truss member assembly **13** tension loading. Under tension load, one of the sleeve's **84** circumferential welds attached to the steel tube element **80** or **81** will fail. This allows for the two steel tube elements **80** and **81** to begin separating and drawing their respective wedges with them. The wedges **82** and **83** move in opposite directions causing their combined cross-sectional area to increase. This area increase is resisted by the circumferential strength of the steel tube elements **80** and **81** and sleeve **84**. Additionally, since the steel tube elements **80** and **81** and sleeve **84** have a certain amount of elasticity, a pressure is imparted at the interface of the wedges **82** and **83**, and steel tube elements **80** and **81**. There is a frictional force resistive to relative movement as this mechanism progresses. The frictional forces are dependant on the intensity of the pressure and the associated area of the pressure. A substantial amount of energy is absorbed with this mechanism.

FIG. **13** is an isometric of a space truss assembly **50** which is utilized where larger distances are needed between primary hull **3** and auxiliary hull shell **2** or if additional support of the auxiliary hull shell **2** is required. The outer member assembly **55** of the space truss assembly **50** may have energy absorbing compression properties similar to that of the compression truss member assembly **10** in FIG. **3** or energy absorbing tension properties similar to that of the tension truss member assembly **13** in FIG. **12**. Intermediate diagonal member **58** provides structural support for the space truss assembly **50** Intermediate horizontal member **59** provides lateral support for outer member assembly **55**. As drawn and described in this embodiment the space truss assembly **50** has nine base points attached to the auxiliary hull shell **2** and one top point attached to the primary hull **3**. This design as compared to a planer truss structure illustrated in FIG. **2**, FIG. **3** and FIG. **4**, provides greater support and reduces panel size to one quarter the area for the auxiliary hull shell **2**.

FIG. **14** is an isometric of an alternate form of the laminated plate assembly **9**, shown in FIG. **5**, where a shaped interior plate **34** is used to provide additional stiffness to resist bending of the shaped laminated plate assembly **41**. The lower surface **35** of this shaped interior plate **34** has been contoured to facilitate bonding with center plate **17** using a structural adhesive **19** or a slot weld **20**. End tongue piece **36** and end groove piece **37** are similar to **21** and **22** of FIG. **5**, except for a raised top interface surface **38** and **39** to facilitate welding of the shaped interior plate **34**.

FIG. 15 is an isometric of a transition stress/deflection controlling device **40**. The cross section **42** is a geometric shape which has been tapered to allow for transition between the auxiliary hull shell **2** and the primary hull **3**. The cross section **44** is flatten to avoid any secondary or excessive stresses from the deflection of the device **40**.

FIG. 16 is an isometric of the construction support assembly **60**. This construction support assembly **60** allows for the maximum pre-arrival construction of the auxiliary hull **1**. Said assembly **60** allows for easily deformable support points for load distribution, and allows the ship to be dry-docked over its new auxiliary hull **1**. Compression truss member assemblies **10**, as shown in FIG. 3, and tension truss member assemblies **13**, as shown in FIG. 12, because of the length adjustment nature of their construction, to allow for docking clearance and ease of installation due to primary hull and auxiliary hull irregularities, can be recessed before final positioning and welding.

FIG. 17 is a cross section of the construction support assembly **60**. The upper yoke assembly **61** is a weldment which provides a slot **71** to allow movement for proper load distribution of the block loads, along the primary hull **3**, during dry-docking and serve as a guide to maintain alignment with the lower plating **69**. Block material **70** is an easily deformable material such as wood which will permit easy redistribution of docking loads similar to conventional docking blocks. The top plate **62** of the upper yoke assembly **61** distributes loads and can be easily welded to the primary hull **3**. Side plates **63** are positioned to form a slot **71**. The lower surfaces **65** of the side plates **63** have been trimmed to provide clearance for welds **72** after docking, with the lower support plate **73** of the upper yoke assembly **61**. Once docked the upper yoke assembly **61** can be welded to the lower plating **69** to permit the construction support assembly **60** to act as a permanent load carrying member. Side chocks **64** connect the top plate **62** to the lower support plate **73** and act to transfer load during docking. Support shelf **67** provides support for the block material **70**. The lower side chocks **68** provide structural support for both the support shelf **67** and the lower plating **69**. The construction support assembly **60**, because of the extra support provided by the support shelf **67** and lower support plate **73**, will act as a energy absorbing member during a collision. Once welded in place the construction support assembly **60** will allow for conventional dry-docking on the new auxiliary hull **1**, by transferring loads directly to ships primary docking structures.

FIG. 18 is an isometric of a compression truss member assembly **92** formed by a steel tube element **90** and a steel tube element **91** which are connected to an intermediate guide **93** using upper weld **96** and lower attachment weld **95**. Intermediate guide **93** is of smaller cross-section which will fit into steel tube elements **90** and **91**. Failure of the lower attachment weld **95**, due to compressive axial loads, will cause the compression truss member assembly **92** to shorten in length until the steel tube element **90** mates and is supported by the new interface formed by the upper weld **96** and the failed lower attachment weld **95**. This new truss member assembly configuration, because of its reduced length will support increased load and will increase the impact energy absorbing capacity of the compression truss member assembly **92**.

FIG. 19 is an isometric of two laminated plate assemblies **9**, illustrating the joining of these assemblies using a tongue **45** and groove **46** design. The tongue **45** and groove **46** can be formed by interior plate **18**, center plate **17**, and exterior plate **16**, of similar dimensions, sandwiching them together and shifting the center plate **17** on a diagonal. In this configuration the three plates can be joined together forming two tongues **45** on adjacent edges and two grooves **46** on the other edges. Joining of these laminated shell assemblies **9**, is accomplished by a butt weld **47** between interior plates **18** of adjacent laminated shell assemblies **9**, and exterior plates **16** of adjacent laminated shell assemblies **9**. This eliminates the need to cut plates to form the tongues **45** and grooves **46**.

FIG. 20 is an isometric of the laminated plate assembly **9**, were an intermediate bar support **99** has been formed by bent steel bars which have a welding flat **97**. The ends of the intermediate bar support **99** are welded to a bar flange **98**. The combination of the laminated plate assembly **9**, the intermediate bar support **99** and the bar flange **98**, form a stiffened laminated plate assembly **100** which uses truss-like behavior to provide additional stiffness to resist bending of the laminated plate assembly **9**.

We claim:

**1**. A structural auxiliary hull, to provide a boundary in addition to a primary hull, said auxiliary hull comprising:

a shell and structural members, wherein said shell is supported by said structural members, arranged in a geometric pattern, wherein the ends of one or more said members meet in proximity of discrete connection points, for load transfer, on the shell of said primary hull, and said shell of said auxiliary hull, and;

wherein a portion of said structural members, for ease in fabrication, are comprised of at least two elements, and;

wherein said structural members, for additional structural integrity, are assemblies comprised of at least two telescoping elements connected by a restrained engagement whereby said telescoping members can support load by one of telescoping movement, deformation of said restrained engagement, and both telescoping movement and deformation of said restrained engagement.

**2**. A device as set forth in claim **1**, wherein said structural members, for energy absorption, are assemblies comprised of at lest two elements connected by a restrained engagement wherein said members can support load by forces developed along inclines by deformation of said restrained engagement.

**3**. A structural auxiliary hull as set forth in claim **1**, wherein a portion of said structural members are connected to said primary and said auxiliary hulls using devices with a base for attachment to said auxiliary or said primary hull, and at lest one appendage for mating with said structural member to facilitate assembly over a range of said member lengths.

**4**. A structural auxiliary hull as set forth in claim **1**, wherein a portion of said structural members are comprised of primary members, attached to said primary hull and said auxiliary hull, and horizontal members and intermediate diagonal members, which connect int he proximity of each other along said primary member forming a structural assembly.

**5**. A structural auxiliary hull as set forth in claim **1**, wherein a portion of the volume created between said primary and said auxiliary hulls contains material.

6. A structural auxiliary hull as set forth in claim 1, wherein a portion of said auxiliary hull shell is comprised of laminated plate assemblies.

7. A structural auxiliary hull as set forth in claim 6, wherein a portion of said auxiliary hull shell is comprised of said laminated plate assemblies joined together using tongue and groove joints.

8. A structural auxiliary hull as set forth in claim 6, wherein a portion of said auxiliary hull shell is comprised of said laminated plate assemblies joined together along the perimeter of said plate assemblies using tongue and groove pieces.

9. An auxiliary hull according to claim 1 including a construction support assembly, to transfer loads from dry-docking, comprising:

an upper yoke assembly, which is comprised of a lower support plate, an upper support plate, and said plates which form a slot; and

a lower support assembly comprised of a vertical plate and a reinforced horizontal plate to support block material.

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